REMARKS

Reconsideration of this patent application is respectfully requested in view of the foregoing amendments, and the following remarks.

The amendments to this patent application are as follows. The Specification has been amended on page 5 to correct the minor typographical error referred to on Page 2 of the Office Action. Also the Specification has been amended on Page 1 to include a minor revision to the cross reference to related applications.

The amendments to the claims are to cancel claims 1 to 10 without prejudice and to present new claims 11 to 17. New claims 11 to 15 are directed to the method of the invention, while claims 16 to 17 are directed to the apparatus of the invention. No new matter has been introduced.

For these reasons, it is respectfully requested that the formal objections to the Specification and the claims be withdrawn.

The Applicants comment upon the prior art rejections of the claims as follows:

The present invention is directed to a method of heat treatment of glass materials and natural materials specifically of volcanic origin selected from the group comprising basalt, granite, marble, andesite and syenite, the method including melting and refining said materials to form objects, comprising exposing the treated material to microwave radiation at a frequency range from 1 MHz to 10 GHz and at a temperature range from the ambient temperature to 1800°C in a batch or continuous production process in the presence of an inert, microwave absorbing additive selected from the group comprising carbides, nitrides or borides in an amount from 1 to 100 g per 1 kg of the glass materials or natural materials.

The present invention is also directed to an apparatus for heat treatment of glass materials and natural materials, comprising substantially a microwave furnace comprising an outer shell (8.2) provided with a cover (10) and an inner shell (8.1) and at least one microwave generator (1.1, 1.2, 1.3, 1.4) with double emission and a total output from 0.1 to 1 kW per 1 kg of the processed glass materials or natural materials arranged substantially in an intermediate space between the outer shell (8.2) and the inner shell (8.1); a tank (2) disposed inside the inner shell (8.1) and a heat insulating material (3) filling up an inner space of the furnace between the tank (2) and the inner shell (8.1); and said insulating, microwave permeable material (3) having a heat resistance up to 1750°C

and being selected from the group consisting of aluminum oxide - corundum and silicon oxide - quartz.

In the Office Action, the claims were rejected under 35 U.S.C. 103(a) as being unpatentable over *Childs, Jr. U.S. Patent No. 3,673,288* in view of *Tanaka et al. U.S. Patent No. 4,900,894* and further in view of *Sutton et al. U.S. Patent No. 4,219,361* and *Derwent abstract for Bienvenu (WO9221630)*, and further in view of *Igarashi U.S. Patent No. 5,304,701* and *Hardwick et al. U.S. Patent No. 4,490,287* and further in view of extrinsic evidence from the *Corrosion and Chemical Resistant Masonry Materials Handbook*, and further in view of *Gallawa, The Purpose and Function of Interlock Switches*, *Valentine U.S. Patent No. 4,126,651* and *Monaghan U.S. Patent No. 4,399,544*.

Childs (U.S. Patent No. 3,673,288) in column 1, lines 8 to 18, discloses the manufacture of basic refractory articles such as tar-bonded dead-burned dolomite, periclase and/or magnesite bricks. The usual manufacture of tar-bonded basic refractory brick involves the mixing of dead-burned refractory grains with hot pitch or tar, after which the mixture is maintained hot to insure adequate mobility of the material under pressure and then pressed into the desired shape. After pressing, the bricks are normally tempered by the application of heat at a relatively low temperature, i.e. below coking temperature.

Furthermore, *Childs* in column 1, lines 67 to 75, and column 2, lines 1 to 34, discloses that microwave energy in the 900 to 25,000

MHz range may be used in the tempering of tar-bonded refractory articles. Experiments have shown that both 915 MHz and 2,450 MHz units can be used to heat tar-bonded bricks. Of the two frequencies, the 2,450 MHz is more satisfactory although it is more expensive to purchase the equipment. At 2,450 MHz a faster heating rate may be obtained and a more uniform heating across the length and cross-section of the brick is provided. Also, at 2,450 MHz the tar content may be varied over a wider range than can be used in a 915 MHz unit. Successful tempering can be obtained in a 915 MHz unit if care is taken not to have tar contents above 4.5 percent and the cavity is carefully designed for proper absorption of energy by the load.

In *Childs*, the microwave energy penetrates the mineral and creates vibrations within the molecules of the tar upon which it acts. These vibrations cause molecular or internal friction which heats the tar uniformly. Because of the uniformity of heating, the tar can be heated very rapidly without the formation of defects in the interior or at the exterior of the refractory body. Microwave tempering produces bricks with properties comparable to those found in bricks or other refractory articles tempered by conventional heating for much longer time periods. The microwave energy can be applied directly to the refractory article and, consequently, energy is not lost by heating up the air or any parts of the oven housing.

In *Childs*, in the case of tar-bonded basic refractory articles or bricks, the microwave energy acts only on the tar and not the stone.

Unexpectedly, though, only the tar is directly affected by the microwave energy and comprises a minor proportion of the mass, the entire brick, can be uniformly and rapidly heated. Even though refractory bricks are not homogeneous, it has been found that the tar in the center of the brick can be heated at the same time as the tar on the outside of the brick. Because of this uniformity in heating, the volatiles can be released from the center of the brick and are not trapped in the interior by the premature tempering of the outside of the brick. It has been found that the growth of the brick is minimized during tempering and the brick density thereby maintained.

Thus, the primary reference to *Childs* fails to teach or to suggest the claimed method concept of heat treatment of glass materials and natural materials and the method including melting and refining said materials to form objects, comprising exposing the treated material to microwave radiation in a presence of an inert, microwave absorbing additive selected from the group comprising carbides, nitrides or borides in an amount from 1 to 100 g per 1 kg of the glass materials or natural materials.

Hence, the primary reference to *Childs* also fails to teach or to suggest the claimed apparatus concept of a microwave furnace which includes a tank (2) disposed inside the inner shell (8.1) and a heat insulating material (3) filling up an inner space of the furnace between the tank (2) and the inner shell (8.1); and

said insulating, microwave permeable material (3) having a heat resistance up to 1750°C and being selected from the group consisting of aluminum-oxide-corundum and silicon oxide-quartz.

The deficiencies in the teachings of the primary reference to *Childs*, are not overcome by the disclosures of the following secondary references.

Sutton (U.S. Patent No. 4,219,361) in column 1, lines 8-12, relates to a method of improving the susceptibility of a material to microwave energy reaction and to making an article including this material which can be heated directly by microwave energy.

Furthermore, in column 2, lines 45 to 68, and column 3, lines 1 to 2, *Sutton* discloses that materials which are not susceptible to heating by means of microwave energy can be rendered susceptible to heating by microwave energy when a reactive agent is added to such material. For purpose of identification, a reactive reagent will be defined as a compound which when mixed with another material not susceptible to microwave energy will render the mixture susceptible to heating by microwave energy radiation. A material which is readily heated by means of microwave energy (class 3) will be considered to be a material which "strongly couples" to microwave energy. A material which cannot be heated by microwave energy (classes 1 and 2) will be defined as a material which is "non-coupling" to microwave energy radiation. Those materials which can be heated by means of microwave energy radiation, but which do not heat too well or for which the

temperature cannot be raised very much, will be designated as a "weak-coupler". These are those which fall in the gray area between classes 2 and 3. It has been found that those materials which act as "strong-couplers" to microwave energization when associated with a material which is a "non-coupler" or "weak-coupler" (hereinafter referred to as non-susceptible) will render the entire mixture readily susceptible to heating by means of microwave energy.

Therefore, *Sutton* and also *Bienvenu* teach a composite material for forming objects from a microwave permeable material in combination with a microwave impermeable material to enable a final product to be directly heated by the microwave energy.

Contrary to those secondary references, the claimed method is directed to the use of a microwave absorbing material in the process as a supporting agent to permit the melting of glass or defined volcanic materials that are otherwise not susceptible to microwaves. The microwave absorbing material has been selected from a certain group of additives that comply with the conditions that such additives do not react (contrary to for example *Sutton*-claim 1) with the glass or volcanic material and even do not constitute a part of the final product. This condition is contained in the claimed limitation "<u>inert material</u>". One skilled in the art knows that in the claimed process as described in the present Specification, the inert components are in the final stage separated as a surface slag from the melt.

Thus, the secondary references to *Sutton* and *Bienvenu* do not teach or suggest the claimed method or the claimed apparatus.

Tanaka fails to teach any additive to enable heating of a glass material or volcanic material to a melting point and refining it. *Tanaka* uses for the preheating step up to the temperature where quartz is susceptible to microwaves a gas plasma generated on the tip of an electrically conductive rod inserter into the quartz tube and heated. This is a very different technology applicable to the preparation of quartz glass optical fibers and does not motivate a person skilled in the art to replace the gas by an inert additive as claimed. Specifically, the process claimed in the instant application is directed to the heat treatment of solid glass cullet, of batches and a defined types of volcanic materials.

More particularly, *Tanaka et al (U.S. Patent No. 4,900,894)* in column 1, lines 5 to 12, discloses a method of heating a quartz glass tube, by using a microwave, which method is suitable for the preparation of a quartz glass optical fiber since the glass tube can be quickly heated without contamination from a heat source.

Furthermore, in column 1, lines 47 to 68 and column 2, lines 2 to 3 of *Tanaka et al,* it is disclosed that without employing a wasteful method which comprises preheating the quartz glass with the external heat source such as the oxyhydrogen burner and then transferring the preheated portion of the quartz glass to the microwave applicator, it has been found to provide a method wherein the quartz glass is

preheated in the microwave applicator and the microwave is applied to the quartz glass in the applicator, Also, it has been found that a hot plasma can be generated from a gas from which plasma is easily generated can be utilized for preheating the quartz glass.

Hence, *Tanaka* discloses a method of heating a quartz glass tube with a microwave, which method comprises supplying a gas for plasma generation in the quartz glass tube, applying a microwave to the quartz glass tube so as to generate a hot plasma in the quartz glass tube and to pre-heat the quartz glass tube, and then discontinuing the supply of the gas for plasma generation while applying the microwave, thereby causing the quartz glass tube to absorb the microwave.

Thus, *Tanaka* fails to teach or suggest the claimed method and apparatus.

Igarashi (U.S. Patent No. 5,304,701) in column 1, lines 6 to 9, discloses a melting furnace for treating industrial wastes, particularly high-level radioactive wastes, and a heating method of the melting furnace.

Furthermore, *Igarashi,* in column 2, lines 35 to 65 discloses that the melting furnace for treating wastes comprising a container equipped with a feed port for a glass raw material and wastes to be treated at the top thereof and a discharge port for molten glass containing the wastes at the bottom thereof, a heating electrode disposed in the container, and cooling means disposed at the back of a wall of the container. The container wall is made of a heat

resistant alley. It is in contact with molten glass inside the container, and acts as a counter electrode of the heating electrode.

In *Igarashi*, there is also provided a heating method for the above-described melting furnace comprising supplying electric power to the glass between the heating electrode and the container wall to heat and melt the glass while cooling the container wall by operating the cooling means.

In the preferred embodiment of *Igarashi*, heating means is disposed in the proximity of the discharge port for the molten glass so that the molten glass accumulated at the bottom of the container is heated by the heating means in such a manner as to be capable of flowing out of the discharge port when the molten glass containing the wastes is withdrawn from the discharge port. As the heating means, an induction heating coil or a resistance heating element may be employed. A bottom wall of the container is preferably provided with an inclination extending toward the discharge port for the molten glass.

Hardwick et al (U.S. Patent No. 4,490,287) in column 1, lines 9 to 36, discloses the treatment of substances by the incorporation of radioactive wastes in a solid material (i.e. solidification and vitrification of radioactive waste) for the purposes of handling and storage.

According to one aspect of *Hardwick et al* there is provided a process for the treatment of a substance contained in a solution or a

slurry which includes subjecting the solution or slurry to the influence of microwave radiation to produce a fusible dried product, said fusible dried product including a dried form of the substance, and heating the fusible dried product to fuse it.

The distinguishing claim limitations of the apparatus of the invention are as follows:

(i) The microwave generators are arranged substantially in the intermediate space between the outer shell (8.2) and the inner shell (8.1). Neither *Igarashi* nor *Hardwick* disclose a furnace with such specific location of generators.

(ii) The whole space between the tank and the inner shell is filled up with the heat insulation material.

In addition to the above, the *Igarashi* furnace is designed for treating wastes of high radioactive material to obtain vitrified and immobilized product and not a high quality product made from glass or volcanic materials such as basalt. The furnace design is pre-determined by the heating device i.e. resistance heating device with one electrode submerged in the material treated. As a subsidiary heat source, an electromagnetic horn 17 situated on the upper cover and assigned to apply microwaves on the glass surface inside the container, may be used.

The space between the tank and the inner shell is not filled up with insulating material but provided by chambers for cooling air.

Thus, all advantages of the microwave heating are avoided by using substantially a resistance heating.

Also, *Hardwick* teaches a method and apparatus designed for the similar purpose as that of *Igarashi*. The treatment of radioactive substances includes two stages i.e. drying of the radioactive substance and then the coating of the glass formers with said dried substance (claim). The process is carried out in a vessel surrounded with Vermiculate thermal insulation and silica/alumina thermal insulating bricks. The vessel together with the two-layers insulation jacket is placed in an oven to let a substantial free space between the oven wall and the insulation with the exception that the bottom of the insulation jacket rests on the oven bottom. The microwave radiation is introduced into the free space through a waveguide. On the contrary, the apparatus according to the invention includes the limitation that the heat insulating material fills up the inner space of the furnace between the tank and the inner shell. This arrangement is crucial for the distribution of the microwave radiation within the tank and contents thereof. Moreover, it is to be noted that the Vermicular insulation is a substantial microwave absorber.

Therefore, it may be concluded that neither *Igarashi* nor *Hardwick* would teach one skilled in the art the method and apparatus claimed in the instant application.

Valentine (U.S. Patent No. 4,126,651) in column 2, lines 45 to 65, discloses a process for fabricating foundry casting components,

i.e. molds and cores, from gypsum-containing plaster in accordance with which such components can be dried by a single stage microwave radiation treatment as satisfactorily as, and even more quickly than, by the method of the referenced application. *Valentine* is based on the discovery that if such a casting component is subjected to microwave radiation while it is insulated by a medium which is pervious to both the radiation and to water vapor, but which substantially prevents heat radiation from the surface of the component, the water will be completely eliminated from the component without developing such high temperatures in the interior of the component as will dead burn the plaster.

Monaghan (U.S. Patent No. 4,399,544) in column 1, lines 10 to 12 discloses a high temperature electronic furnace suitable for converting fly ash into mineral wool.

Furthermore, *Monaghan* in column 2, lines 54 to 68 and in column 3, lines 1 to 2 discloses a furnace and method of operation which can effectively convert large quantities of fly ash into mineral wool.

Monaghan provides an electronic furnace and method which is capable of electronically generating a large amount of heat at a precisely controlled temperature over an exit orifice of a melting vessel in order to permit large amounts of fly ash immediately over that orifice to be raised to a precise temperature and to permit controlled flow of that fly ash through the orifice to produce large quantities of mineral wool.

Furthermore, *Monaghan* in column 3, lines 12 to 22, discloses a melting furnace which comprises: (a) a vessel for receiving product to be melted, the vessel having a product exit orifice; (b) a plurality of primary electrodes for defining primary current paths adjacent the orifice; (c) a control electrode means for defining a current path to the orifice; and (d) a circuit means for energizing the primary electrodes with multiphase current and for time-sharing the multiphase current with the control electrode.

Gallawa in *"The Purpose and Function of Interlock Switches"* recites that to ensure safe operation, all microwave ovens are equipped with safety interlock switches. The door-interlock system is one of the most significant safeguards in the microwave oven.

It is disclosed in *"Corrosion and Chemical Resistant Masonry Materials Handbook"* that a variety of refractory materials are available which provide for a wide range of service temperatures from ambient to 3300°F.

Sklyarevich et al (U.S. Patent No. 6,408,649 B1) in column 1, lines 7 to 19, discloses an invention relating to the thermal treatment of any type of glass and glass-like materials, preferably of a glass sheet for shaping, bending, tempering, annealing, coating and float processing by rapidly and uniformly heating the glass sheet with microwave radiation so that the glass sheet can be processed without cracking. Glass and glass-like materials which may be thermally treated by the inventive method include flat glass sheets, glass

fibers, organic mixtures incorporating glass and glass-like materials and the like. Glass sheets treated by this method can be used in the production of windshields, side windows and rear windows in vehicles such as automobiles and the like as well as for the production of architectural window glass and the like.

Thus, none of these references teach or suggest the present invention as claimed.

INFORMATION DISCLOSURE STATEMENT

Enclosed herewith is PTO Form-1449, which includes two references (*U.S. Patent No. 5,822,879* and *Canadian Patent No. CA 2242893*) which were cited by the Russian Patent Office in the proceeding relating to the Russian counterpart of this application, and are discussed below. A copy of the Canadian Patent is enclosed.

U.S. Patent No. 5,822,879 discloses a device for vitrifying radioactive and toxic waste consisting substantially of a tube forming a melting bath having a microwave generator located at one and a movable microwave reflecting surface at the other end so as to permanently vary the position of the aninodes (strong microwave fields) of the stationary wave and thus homogenize the temperature of the melting bath.

Naturally, such a device is not assigned to meet the requirements for a manufacture of high quality of glass or natural materials as specified in our application. In contrast with the U.S. Patent, our application includes several substantially

distinctive features specified hereunder and contained in the claims on the basis of which high quality products made of glass and natural materials may be produced:

1. Specific additives are added that enable that the melting process is extremely accelerated and the process speed is determined only by the heat resistance of a crucible/tank. Such inert materials are strong absorbers of microwaves even at the ambient temperature while the properties, of the glass or natural materials, what is of importance, remain unaffected.

2. The furnace is designed to contain a tank surrounded by a specific type of heat insulation in the space located between the tank and the inner shell wall. This arrangement prevents the melted material from local overheating, provides for uniform material structure and contributes to a uniform distribution of the microwave energy.

3. Contrary to the U.S. Patent, the microwave generators are arranged in the intermediate space between the outer shell (8.2) and the inner shell what enables the modification of melting regime to improve the homogenous properties of the melt for example in production of fibers and contributes to a uniform distribution of the microwave energy. Accordingly, besides the mere melting purposes, the furnace may be used for refining, hardening or forming various glass materials and volcanic origin materials such as basalt.

The method and apparatus according to *ca 2242893*, as with the U.S. Patent, also relate to the vitrifying the radioactive waste. Accordingly, the apparatus and method are not designed to meet the requirements for the manufacture of high quality glass or natural materials products as specified in our application. Therefore, the method and apparatus according to this patent are based on several substantially different elements in comparison with our application:

1. The microwave furnace according to the Canadian Patent is provided by cooling to enable <u>formation of a crucible of the same material</u> as the material processed. For the formation of the crucible, the argon gas is supplied into the microwave cavity to generate argon plasma on the axis of the cavity.

2. The space between the crucible and the furnace walls is filled up by non-melted frit particles.

Because the Information Disclosure Statement is being filed after an Office Action on the merits, a check in the amount of $180.00 is enclosed for the Official Fee. Please charge any additional fee, or credit any overpayment in connection with this IDS, to Deposit Account No. 03-2468.

CONCLUSION

In summary, claims 1 to 10 have been cancelled, and claims 11 to 17 have been added. In view of these amendments, all of the claims as amended are patentable under 35 U.S.C. 103 over all the

prior art applied by the Patent Examiner. Withdrawal of this ground of rejection is respectfully requested. A prompt Notification of Allowability is respectfully requested.

Respectfully submitted,

HAJEK ET AL 1 - PCT

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I hereby certify that this correspondence is being deposited with the U.S. Postal Service as first class mail in an envelope addressed to: Commissioner of Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on December 30, 2004.

Maria Guastella